Public Health Assessment for

ANNAPOLIS LEAD MINE
ANNAPOLIS, IRON COUNTY, MISSOURI
EPA FACILITY ID: MO0000958611
SEPTEMBER 7, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

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EPA FACILITY ID: MO0000958611

Prepared by:

Missouri Department of Health and Senior Services
Division of Environmental Health and Communicable Disease Prevention
Section for Environmental Public Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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SUMMARY

The U.S. Environmental Protection Agency (EPA) proposed the Annapolis Lead Mine (ALM) Site for the National Priorities List (NPL) on March 8, 2004. The final rule to add the ALM site to the NPL was published in the July 22, 2004 Federal Register, with an effective date of August 23, 2004. It was listed primarily because of elevated levels of heavy metals, particularly lead, which were present throughout the site. In addition, surface water bodies located downstream from the site contained elevated concentrations of site-related hazardous substances that could pose a threat to recreational fisheries and wetlands in the area.

The Annapolis Lead Mine (ALM) site is an inactive lead mine located in Iron County, Missouri, approximately one mile east of the town of Annapolis. Galena (lead-bearing ore) mining began at the site in the 1920s and continued sporadically until 1940.

Mining activities that took place at the site included excavation of ore bodies, crushing and concentrating of ore, and storage of concentrated metals prior to shipment offsite for smelting. The crushing and concentrating wastes (tailings) were disposed of on the property in a ravine that is a tributary of Sutton Branch Creek. The resulting pile of waste was highly erodible, having steep sides and an outwash area that fanned westward towards Sutton Branch Creek.

Sutton Branch joins Big Creek, which flows approximately 15 miles downstream from the ALM site into Sam A. Baker State Park near Patterson, in Wayne County, Missouri. Within the park, Big Creek joins the St. Francois River and empties into Wappapello Lake. Appendix A, Figure 1 provides a map of the area.

In 1997, elevated levels of arsenic, cadmium, copper, lead, nickel, and zinc were present in on-site soil and groundwater. Surface wipe samples taken from various floor locations in an on-site residence (former mine building) contained lead at levels that exceeded EPA standards for interior lead. These results, along with the results from blood-lead samples taken from the children living on-site, were used in determining that the individuals were being adversely affected by living on-site. In May 997, EPA completed a Removal Action, which included the relocation of the family from their residence on the site.

As a result of the elevated levels of contaminants detected in the samples, the Expanded Site Inspection/Removal Assessment recommended that a second removal action be completed on-site to eliminate the threat of exposure to hazardous substances that were present at the site. In September 2003, EPA proposed a time-critical removal action for the ALM. The goal of the removal action was to identify, consolidate, and stabilize the lead contaminated mine tailings on-site. The time-critical removal action plan was finalized, with work beginning at the site in February 2004. Settling basins were constructed immediately to manage storm water runoff. The tailings and contaminated soil have been formed into a mound in the middle of the ravine where the pile was originally deposited. The new pile was capped with clean soil that should allow vegetation to grow. EPA completed the time-critical removal action in late 2004.

There have been reports that the tailings materials were used around the town of Annapolis for residential driveways, fill for roads, and as playground surface covering. If the tailings were

distributed around town, there is the potential for residents to be exposed to contaminated materials. EPA sampled 16 residential yards within the town of Annapolis. Fourteen of the yards did not have lead at levels of concern. Two yards had elevated levels of lead but were not significant enough to warrant immediate action.

Recent sampling indicates that the surface water and sediment in Big Creek within Sam A. Baker State Park do not have elevated levels of contaminants from the ALM site. However, it is not known whether parts of Sutton Branch and Big Creek farther upstream and nearer to the ALM site have elevated levels of contaminants. If these surface water bodies are contaminated, there is the potential for human exposure. EPA plans to conduct a remedial investigation to determine the nature and extent of contamination south of Highway 49. Based on the results of the investigation, future cleanup actions will be determined.

Sampling results indicate that in the past, on-site residents were exposed to elevated levels of arsenic, cadmium, copper, iron, lead, nickel, silver, thallium, and zinc. It is also possible that visitors to the site and to Sutton Branch Creek, along with nearby residents, could be exposed or have been exposed to contaminated surface water, or soil. Therefore, the ALM site is considered to be a *Public Health Hazard* for past exposures. EPA has completed a time-critical removal action at the site. As a result, the migration of contaminants from the site has been significantly reduced. Legal and physical restrictions will be put in place to restrict future exposures. The completion of the time-critical removal action makes the tailings pile area less of a physical hazard. The mounded soil in the ravine should be fairly stable and covered with vegetation. Several old mine building foundations will be left on-site in various stages of deterioration. They could be unstable and prone to collapse, potentially causing a physical hazard to those on-site. Physical barriers will prevent trespassers from being on-site; therefore, preventing exposure to on-site physical hazards. The onsite areas of the ALM site are considered to be a *No Apparent Health Hazard* for present and future exposures. Experience at other mining sites indicates that contaminants from the site may have migrated downstream from the site. However, this possibility is yet to be investigated. This off-site area surrounding the site where contamination has migrated is considered to be an *Indeterminate Health Hazard* for present and future exposures.

PURPOSE AND HEALTH ISSUES

The Missouri Department of Health and Senior Services (DHSS), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), is evaluating the public health impact of the Annapolis Lead Mine (ALM) Site. ATSDR is a federal agency authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments at hazardous waste sites.

The Environmental Protection Agency (EPA) proposed the Annapolis Lead Mine Site for the National Priorities List (NPL) on March 8, 2004, because elevated levels of heavy metals, particularly lead, were found throughout the site. The final rule to add the ALM site to the NPL was published in the July 22, 2004 Federal Register, with an effective date of August 23, 2004. In addition to on-site contamination, surface water bodies located downstream from the site contained elevated concentrations of site-related hazardous substances that pose a threat to recreational fisheries and wetlands in the area. This public health assessment will assess past, present, and future exposures to contaminants at the site. It will determine if any past, present, or future exposures are at levels expected to cause adverse health effects. If necessary, this assessment will also recommend actions to reduce or prevent possible adverse human health effects from exposures to this site.

BACKGROUND

The Annapolis Lead Mine (ALM) site is an inactive lead mine located in Iron County, Missouri, approximately one mile east of the town of Annapolis. Galena (lead-bearing ore) mining began at the site in the 1920s and continued sporadically until 1940. Since 1919, several companies have owned the Annapolis mine, mining operations and associated mineral rights. Currently, the site property is divided into four parcels and owned independently by individual citizens. See Appendix A, Figure 1 for a map of the site area.

The Annapolis Lead Company reportedly owned/operated the mine at the site from 1919 until 1931. Production figures indicated that approximately 1,173,000 tons of mining wastes were generated during this time period (1). The Ozark Lead Mining Corporation owned the property from 1931 until 1941, but only conducted mining activities from 1938 until 1940. It appears that no mining activities took place on-site after that time. The site and the associated mineral rights have been bought and sold several times over the years. Since 1987, the Doe Run Company has owned the mineral rights. As of 1999, the property was separated into parcels owned independently by several individuals. One family lived on the property sporadically in one of the former mine buildings, and another family had at one time planned to reside on-site. At this time, the on-site residences are uninhabited.

The ALM site is situated on relatively rugged terrain that slopes westward toward Sutton Branch Creek (1). The site is partially wooded. The tailings pile and the mine building areas are mostly unvegetated. The site is not fenced and is easily accessible to the public. Trails were visible through the tailings area, reportedly used for motorcycles and all terrain vehicles. The land surrounding the site is predominately forested, with limited agricultural production and isolated residential properties.

According to mining records, the ALM had one main shaft that has since been filled in. At one time, it extended 450 feet below the ground surface with several hundred feet of laterals to work the ore bodies (1). Mining activities that took place at the site included excavation of ore bodies, crushing and concentrating of ore, and storage of the concentrated metals prior to shipment offsite for smelting. The crushing and concentrating wastes (tailings) were disposed of on the property in a ravine that is a tributary of Sutton Branch Creek. At one time, the resulting pile of tailings occupied approximately 10 acres of the estimated 50-acre site. Numerous former mining operation buildings are still present on-site, mostly in the northern portion. Most of the buildings have deteriorated to the point where only foundations are present. One exception is a single story of a once multi-storied structure near the center of the site, which has been used sporadically as a family residence. Other mining refuse is interspersed among the building remains (1). At one time, there was a mill slime pond located about 300 feet north of the tailings pile. The mill slime is fine-grained wastes from the milling process that was disposed of as a slurry into a pond. See Appendix A, Figure 2 for a map of the site.

The 10-acre tailings pile is composed of grey to tan colored material that resembles fine-grained sand. Tailings are classified as medium to fine sand-sized particles that are a waste product of the froth floatation-level extraction process. Chat is defined as crushed ore material that is 3/8 inch or less in diameter. Chat is a waste product from the density separation process. Tailings and chat are highly erodible. At one time, the pile had steep sides and an outwash area that fanned westward towards Sutton Branch Creek. EPA stabilized and capped the pile to prevent further erosion.

There are three groundwater wells on-site, one in surface materials (used for irrigation) and two into bedrock (reportedly used for drinking at the on-site residences). At least two artesian wells are present within a one-mile radius of the site. Artesian wells flow spontaneously (like a fountain) from internal pressure. One of these wells is just northwest of the site and has been used for drinking by Annapolis residents who traveled past the site on route to the old city dump (2). The depth of this well is not known but it is probably drilled to the Bonne Terre or Lamotte Formation. Another artesian well within a mile of the site penetrates the Cambrian section and the upper part of the Precambrian igneous rocks for a total depth of 427 feet (2). This well was reported to flow at 3 gallons per minute (gpm). The rural residences in the area have wells constructed in either shallow alluvium or bedrock aquifers. Another nearby well (Missouri Geological Survey Well No. 300) was drilled to 170 feet from the Potosi into the Derby-Doerun, yielding 12 gpm with no drawdown (2). An inventory of wells registered by MDNR indicates that there are 27 wells within a four-mile radius of the site. In addition to one city well, six wells in Annapolis are completed in shallow alluvium between 10-32 feet. This water is used for washing aggregate utilized for roofing manufacturing at a nearby business, ISP Minerals, Inc (2).

Except for the rural residences, the population within a four-mile radius of the site receives water from a municipal water supply well. The average annual number of users of the Annapolis water supply is about 600 people, factoring in 400 students at the school for nine months of the year, 100 residential users, and 100 factory workers. Within a quarter mile radius of the mine tailings, approximately 14 people rely on private wells. In addition, an estimated 50 people drink

occasionally from the artesian well located northwest of the site, despite warnings from the Annapolis Water Department (2). The actual number of persons drinking from the artesian well is undetermined.

Overland drainage from the site previously flowed to the west approximately 350 feet into Sutton Branch. Numerous channels carved ravines into the tailings as water drained off the surface of the tailings. Along the main intermittent drainage on the northern portion of the pile, there was abundant evidence of contaminated source material being washed into Sutton Branch (2). Deposition was most likely occurring during rainfall events where material from the site was being washed from the tailings area into Sutton Branch. The water in Sutton Branch during relatively low flow has a greenish tinge, and during high flow has abnormal quantities of suspended-load sediment derived from the site (2). Sutton Branch is a small creek that contains minnows and crayfish. It is reported that local residents may occasionally eat the crayfish. It is classified as an intermittent stream. Surface water may pond in low areas, during the periods when the stream is not flowing, sustaining aquatic life (2). Sutton Branch flows approximately 4500 feet before joining Big Creek. Big Creek joins the St. Francois River 20 miles downstream from the site in Sam A. Baker State Park. The confluence of Big Creek and the St. Francois River is just upstream from the upper part of Wappapello Lake (4) (Appendix A, Figure 1).

Sam A. Baker State Park is approximately 15 miles downstream from the ALM site near Patterson, Wayne County, Missouri. The park was created in 1926 near the St. Francois Mountains in southern Missouri. It attracts visitors who enjoy swimming, hiking, fishing, observing wildlife, bicycling, and camping. Canoeing and kayaking are possible on Big Creek and the St. Francois River (3). Wetland areas are found predominantly within the reaches of Big Creek, and minor swampy areas are associated with small drainages in upland tributaries of Big Creek.

Site Investigations

In 1992, the Missouri Department of Natural Resources (MDNR) collected sediment and surface water samples from Sutton Branch Creek. Sample results indicated that the sediments in the creek had elevated levels of lead, copper, nickel, and zinc. Lead was detected in the surface water at 47 micrograms per liter (µg/L) and 98 µg/L, respectively. The federal action level for lead in public drinking water supplies is 15 µg/L. The federal action level is the contaminant concentration found in the environment high enough to trigger additional prevention or removal steps. Sediment samples indicated that lead levels were as high as 4,800 milligrams per kilogram (mg/kg). The federal action level for lead in residential soil is 400 mg/kg. Sediment sampled from the confluence of Sutton Branch and Big Creek contained lead at 4400 mg/kg. Arsenic was found in levels as high as 150 mg/kg. EPA's screening level for arsenic is 23 mg/kg.

Two US Fish and Wildlife Service studies were conducted on aquatic life in Big Creek in 1993 and 1997. Both studies showed heavy metal contamination in fish species. In fact, there is still a problem with lead contamination in Big Creek in Iron County. There is currently a fish advisory

for sunfish and bottom feeding fish in Big Creek near Glover, Missouri. These fish have been found to contain lead at levels of health concern and should not be eaten.

The 1993 study indicated that the fish at the site location downstream of the confluence of Big Creek and Sutton Branch Creek had blood lead concentrations significantly greater than an upstream site location of Big Creek. According to the 1997 report, sampling indicated that fish were accumulating lead and cadmium in Big Creek, and that concentrations in fish were increasing. The ALM site was noted as a probable source by the study and continued monitoring was suggested (1).

In 1995, EPA conducted a Preliminary Assessment (PA) for Site Assessment Activity at the ALM site. The PA concluded that surface water and shallow groundwater would be the most likely routes of exposure. A release of site-related contaminants to groundwater appears plausible after examining the results of the surface water and sediment sampling down gradient of the site and considering the characteristics of the tailings piles and karst geology of the area.

The PA recommended sampling of the groundwater in the area in order to determine the potential impact on shallow aquifers and bedrock aquifers at the site. It also theorized that an exposure threat might have existed for human receptors that consume fish from Big Creek. The PA concluded that there is the threat of continued human exposure onsite due to the contamination present in the unvegetated areas and the potential for the contamination to become airborne by the wind. The PA also recommended sampling of the vegetated areas of the site to determine the true extent of contamination onsite (4).

In 1996, EPA conducted a Screening Site Inspection (SSI) to investigate the threat to human health and the surrounding environment related to the ALM site. The primary concerns were the groundwater, surface water, soil, and air pathways. The sampling activities included the collection of groundwater samples from existing wells, collection of soil samples to establish background levels and impacted levels, collection of sediment and surface water samples, and collection of appropriate quality assurance /quality control (QA/QC) samples (2). No air quality samples were proposed or collected during the SSI activity.

During the SSI, a total of five groundwater samples, nine soil samples, three surface water samples, and three sediment samples were taken from the site. Thirty-four locations were field screened with a portable X-ray fluorescence spectrometer (XRF) unit.

The results of the groundwater sampling investigation indicated the presence of lead at levels above the federal public drinking water supply action level (15 µg/L for lead) in a shallow irrigation well and cadmium in excess of EPA's Maximum Contaminant Level (MCL) (5 µg/L for cadmium) for one of the on-site residential drinking water wells. Lead levels below the action level were detected in both residential wells and the artesian well (2). In addition to the contaminants of concern, elevated levels of thallium were detected in the shallow irrigation well, both of the on-site residential wells, and the artesian well. Appendix B, Table 1 is a listing of the groundwater sampling results from the SSI.

In addition to the soil screening with a portable XRF, nine confirmation soil samples, including one duplicate, were collected and analyzed. The metals of concern were determined by comparing the average of the impacted area samples to the background level determined with the XRF. When the levels found in the soil were more than three times the determined background level, it was assumed that the contamination originated from site activities. The metals of concern detected at a concentration greater than three times the background level included arsenic, cadmium, copper, lead, nickel, silver, and zinc. Other metals detected at a concentration greater than three times the background level included cobalt and thallium (2). See Appendix B, Table 2 for a summary of the confirmation soil analysis.

Three surface water and three sediment samples were collected from Sutton Branch, as part of the SSI activity. The contaminants of concern from this sampling were arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc. All sampling results show the concentration of the contaminants, except chromium, being lowest at the upstream sampling point and progressively increasing from the probable point of entry toward the downstream sampling point (2). Arsenic, cadmium, cobalt, copper, lead, nickel, silver, thallium, and zinc were identified in the sediment of Sutton Branch. In addition, cobalt and thallium were identified in the sediment samples attributed to the mine tailings. Appendix B, Table 3 is a summary of surface water and sediment analysis results.

In 1997, EPA collected groundwater and soil samples from on-site. Elevated levels of arsenic, cadmium, copper, lead, nickel, and zinc were present in the soil and groundwater samples. Samples were also collected in an on-site residence. Surface wipe samples were taken from various floor locations in the on-site residence and lead levels ranged from 0.0319 micrograms per square centimeter ($\mu g/cm^2$) to 0.625 $\mu g/cm^2$ (5). The highest value was in the sample taken from the front entryway of the residence. Interior dust samples were also collected from the floor in the residence using a hand held vacuum. Lead levels in the dust ranged from 523 mg/kg to 1960 mg/kg (5). The highest value was in the sample taken from the living room of the residence. The EPA standards for interior lead are 0.04 $\mu g/cm^2$ for floors.

Three groundwater samples were taken from the wells on-site. Only the shallow irrigation well had an elevated lead level, with a concentration of 51.8 µg/L. Ten surface soil samples were taken from various locations on the property at a depth of 0-2 inches. Lead levels ranged in these samples from 53.4 mg/kg to 5,510 mg/kg (5). The highest level was in the sample taken from behind the on-site residence.

During 1997, the children that resided on-site had their blood analyzed for lead several times. The levels ranged from 11 micrograms per deciliter (µg/dl) to 20 µg/dl. The Centers for Disease Control and Prevention has set 10 µg/dl as the level at which a child's blood lead level is considered elevated. In May of 1997, EPA conducted a Removal Action, which resulted in the removal and permanent relocation of the children and their immediate family from the site (6).

In late 1997 and early 1998, EPA conducted sampling and surveying activities on-site as part of an Expanded Site Inspection/Removal Assessment (ESI/RA). The final report with results of these activities was released on February 19, 1999. The objectives of the ALM site ESI/RA were to estimate the quantity of on-site tailings from the former mining facility that may require

excavation and/or stabilization, to determine the existence and extent of contamination in the underlying groundwater, and to determine the extent of contamination in nearby streams (1). In order to fulfill these objectives, surface and subsurface soil, sediment, surface water, and groundwater samples were collected and analyzed. A total of 19 groundwater, 11 surface water, 19 surface soil (0-6 inches and 6-12 inches), and 13 sediment samples, were collected during the ESI/RA activities, including background and quality control samples. In addition, over 100 *in situ* readings for lead concentration were collected using a field portable XRF. Approximate depths of mining wastes across the site were determined using a Geoprobe™ direct-push apparatus to conduct continuous at-depth soil profiles at 2-foot intervals.

Four lead-contaminated source areas were outlined for removal assessment purposes: the heavily eroded tailings pile, the outwash area of the tailings waste pile, the former mining area, and the mill slime pond. Soil screening with the XRF was conducted in the outwash area, the mill slime pond, the former mining area, and the soils adjacent to the on-site residence. The tailings pile was found to contain mining waste to a depth of 21 feet (1). It was estimated that approximately 51,677 cubic yards of lead-contaminated tailings, chat, and soil above 500 mg/kg were present on-site.

EPA analytical results indicated that heavy metals are present in all four delineated areas. Elevated levels of metals, particularly lead, were found throughout the site. Lead was detected in concentrations in excess of 20,000 mg/kg, in the surface soils adjacent to the on-site residence. Other metals, such as arsenic, cadmium, and zinc were found at three or more times background concentrations in all four delineated areas. However, only arsenic and lead were found to exceed health-based benchmarks. Analysis of samples collected at the tailings pile during the EPA SSI in April 1996 found lead and cadmium concentrations as high as 2,570 mg/kg and 4.67 mg/kg, respectively. Samples collected from the mill slime pond contained lead concentrations as high as 7,000 mg/kg. Appendix B, Table 4 is a listing of the waste/soil sample results from the ESI/RA.

The groundwater data collected during the ESI/RA indicated that cadmium, lead, and zinc were detected in the on-site irrigation well; this suggests that shallow groundwater at the site was contaminated and most likely attributable to the sources on-site. However, the shallow construction and open top of the well allowed for particulates to infiltrate the well, consequently the relationship of the well sample to the local groundwater is not definite. Contaminants were not identified in any of the 14 private wells sampled within a 1-mile radius of the site (ESI/RA). Therefore, contaminated groundwater migration to off-site domestic wells does not appear to be occurring. Current well regulations require the use of a well cap to minimize the risk of contamination by airborne particles. Additional groundwater sampling may be necessary to determine the threat posed to groundwater because of the occurrence of lead and cadmium in several wells on-site during previous sampling, the complex regional geology, and local karst features in the area.

Elevated levels of arsenic, cadmium, lead, and zinc were found during the ESI/RA sampling activity in the surface waters and sediments of Sutton Branch and Big Creek. Cadmium, lead and zinc were detected in the surface water samples at concentrations exceeding background levels. Cadmium levels were as high as 2.49 µg/L, which is three times higher than background

levels (1). Total lead concentrations were as high as 5.60 µg/L at the confluence of Big Creek and Sutton Branch Creek (1). Total and dissolved zinc was detected in concentrations as high as 14.1 µg/L (1). Lead was found as high as 2,600 mg/kg in sediment samples at the tailings pile outfall and as high as 1,700 mg/kg at the confluence of Sutton Branch and Big Creek (designated wetland area), located about 0.75 miles downstream of the site. Appendix B, Table 3 is a listing of the waste/soil sample results from the ESI/RA. Other contaminants including arsenic, cadmium and zinc were also found in sediment samples collected along Sutton Branch and Big Creek at levels above background and ecological screening levels (1).

The furthermost downstream sample location in Big Creek was approximately 1,300 feet downstream of the confluence with Sutton Branch, in a known fishing and recreational area for local residents. The surface water and sediments at this location were found to have elevated concentrations of contaminants attributable to the site. Potential areas of concern include a fishery in Big Creek and numerous wetlands along Big Creek and its tributaries. The MDNR classifies a 5.3-mile portion of Big Creek in Sam A. Baker State Park as an Outstanding State Resource Water, which contains high quality waters with a significant aesthetic, recreational, or scientific value (1). Previous results from two U.S. Fish and Wildlife studies have identified elevated levels of cadmium, lead, and zinc in sediments and fishes in Big Creek downstream of the ALM site (1). Therefore, the ESI/RA concluded that an exposure threat exists for human targets through food chain contamination. Further, elevated metals have been found in a known wetland area at the confluence of the Big Creek and Sutton Branch Creek. This contamination could be affecting the ecological system of this sensitive environment and other wetland systems further downstream. According to the ESI/RA, additional sampling may be warranted to fully examine the contamination and its effects along Sutton Branch Creek and Big Creek.

The ESI/RA recommended that a Removal Action be completed at the site to eliminate the threat of exposure to hazardous substances that were present at the site. In September 2003, EPA proposed a time-critical removal action for the ALM. The goal of the removal action was to identify, consolidate, and stabilize the lead contaminated waste mine tailings on-site. The time-critical removal action plan was finalized, with work beginning at the site in February 2004.

When the removal action began at the site, settling basins were constructed to manage storm water runoff. Then earth moving equipment was used to form the tailings and contaminated soil into a mound in the middle of the ravine where the pile was originally. All areas on the ALM site that had an average lead concentration greater than 1,000 ppm were delineated and excavated. Excavations proceeded to the lesser of a depth of 12 inches or until a lead level below 400 ppm was reached. All excavated areas were backfilled with clean material (<240 ppm lead) and excavated soil was consolidated into the on-site tailings pile (7). The tailings pile was graded and compacted with an engineered protective cover installed over the tailings. The protective cover consists of uncontaminated clay and topsoil, allowing for the establishment of vegetative cover.

This time-critical removal action minimized both the potential for human exposure to lead through contact with the soil and the potential for transport of the tailings by surface runoff, wind, or human activity. Monitoring and site control measures were conducted to ensure removal activities did not expose nearby populations and site workers to harmful levels of

contaminants. The Strategic Plan of Operation provides that EPA and MDNR will collaborate to put future institutional controls in place, both physical and legal. The institutional controls will prevent future exposure to hazardous substances that remain at the site after completion of the removal action. This will be accomplished physically with fencing or other barriers and legally with easements or restrictions on property use (7). EPA plans to revisit the site to ensure that vegetation is growing on the pile and to conduct a final survey of the site. According to the Strategic Plan of Operation, once the protective cover is stable, MDNR has agreed to conduct annual inspections of the site, maintain the protective cover, and implement the required institutional controls.

EPA sampled 16 residential yards within the town of Annapolis. Fourteen of the yards did not have lead at levels of concern. Two yards had elevated levels of lead but were not significant enough to warrant action. Due to the age of the homes and the potential for the presence of lead based paint, it could not be determined if the lead was from the ALM site.

EPA is beginning a remedial investigation to determine the nature and extent of contamination off-site to the south of Highway 49. This investigation will assess the nature and extent of contamination and the current risk to the environment. Based on the results, future cleanup actions will be determined.

Tests of the surface water and sediment in Big Creek in Sam A. Baker State Park were conducted by the MDNR on May 27, 2004, to determine if the runoff from the tailings piles has affected that portion of Big Creek. Water, soil, and sediment samples were taken at four locations throughout the park. Samples were analyzed for arsenic, cadmium, chromium, copper, lead, nickel, thallium, and zinc. Lead levels found in the sediment, soil, and water were significantly below action levels set by EPA. All other contaminants were below comparison values (8).

As part of the Applicable or Relevant and Appropriate Requirements for Discharges to Waters and Groundwater of the State, storm water runoff and discharge from the ALM site is monitored and reported quarterly to MDNR. In the July 2004 report, it was stated that runoff was observed during two rainfall events. During a July rainfall event, grab samples were collected and analyzed for cadmium, zinc, lead, nickel, copper, thallium, arsenic, and chromium (9). Appendix B, Table 5 is a listing of the results from those samples. The results show that the surface runoff outfall that is currently draining from the site into Sutton Branch does not contain elevated levels of any contaminants. The report also lists the best management practices utilized at the site including maintenance of barrier fencing surrounding the sediment collection basins, and placement of silt fencing to capture soils eroding into Sutton Branch (9).

Climate

The climate of Iron County is typical of Missouri with relatively hot, humid summers and moderately cold winters. The majority of the annual precipitation in the area is in the form of rain and is well distributed throughout the year. Snow falls nearly every winter but snow cover usually only lasts a few days. Total annual precipitation is approximately 44 inches (1).

Geology and Land Use

The Iron County area is within the St. Francois Mountains Physiographic Province of Missouri (1) and considered to be in Missouri's "Old Lead Belt". This area's geology is characterized by lower Paleozoic carbonates and siliciclastics onlapping the Precambrian highland mass. Faults cutting both basement and Paleozoic rocks are responsible for much of the mineralization present in the vicinity of the site. Within four miles of the site, the following Cambrian formations have been drilled through or have a well completed within them; in descending stratigraphic order, Potosi, Derby-Doerun, Davis, Bonne Terre, and Lamotte formations (1).

The Potosi formation is characterized as a siliceous dolomite and is somewhat vuggy, or having small cavities, often with a mineral lining of different composition from that of the surrounding rock. The Derby-Doerun formation consists of medium to massively bedded dolomite and is moderately permeable. The Davis formation comprises a shale and dolomite sequence with generally low permeability; however, localized vertical movement of groundwater is via vertical jointing. The Bonne Terre characteristically has several facies and lithologic changes and is locally quite permeable. It is considered a dolomite but may have areas of pure limestone, caves, and solution-enlarged joints. The Bonne Terre formation contains the lead deposits of the area (1).

The Cambrian dolomites in the site area exhibit some karst development. Solution development is greatest near geologic contact with underlying units. Small karst features are evident as numerous caves and springs that occur at relatively comparable elevations along the Big Creek Valley (1). In addition, Sutton Branch Creek was observed to be a losing stream in certain portions (1).

Physical Hazards

At the time of cessation of mining activities on-site, it is believed that a 40+-acre area was covered by mine refuse at least two feet thick. Areas of the site used as dumps or mill settling locations had perhaps tens of feet of relatively fine-grained material placed on the soil. Heavily wooded to partially wooded and weedy parts of the site had unmilled ore and relatively coarse-grained millings strewn about and had little or no soil cover. The pile of tailings occupied approximately 10 acres of the approximate 50-acre site. Evidence was available that indicated the mine tailings area was used for recreation and riding of all terrain vehicles.

Physical hazards at the ALM in the past were associated with the abandoned mines and the tailings piles. Although the main mine shaft has been filled in, other open mine shafts, exploratory mine shafts, or air vents could be present on or near mine properties. These open holes are dangerous to workers or trespassers, especially children who could potentially step or fall into one of the holes. Climbing or walking on the tailings pile could have been treacherous. The pile could have been very unstable; collapse or washouts were possible. Large debris or pieces of steel in the tailings pile or associated with the mine/milling buildings could cause a hazard for anyone walking or riding all terrain vehicles on the piles.

The completion of the time-critical removal action makes the tailings pile area less of a physical hazard. There is a large mound in the ravine, but it should be fairly stable and covered with vegetation. Several old mine building foundations will be left on-site in various stages of deterioration. They could be unstable and prone to collapse, causing a physical hazard to those on-site.

Demographics

According to the 1995 Preliminary Assessment, there were approximately 160 people permanently inhabiting the area within a one-mile radius of the site. There are approximately 276 residences within 1.5 miles of the site. The total population within a four-mile radius of the site was estimated to be 1338 at that time. The nearest school is located approximately 1.25 miles due west of the site. Approximately 400 students attend the Annapolis school and about 100 workers are employed at the ISP Minerals, Inc., both of which are located on the other side of Annapolis, approximately 1.5 miles from the site.

DISCUSSION

In the past, on-site residents were exposed to high levels of contamination from the mine waste deposited on the ALM site. Previous sampling results indicated elevated levels of arsenic, cadmium, copper, iron, lead, nickel, silver, thallium, and zinc were present on-site in the groundwater, soil, or both. The soil exposure pathway posed the greatest threat to human health in the past due to the lack of vegetation on exposed contaminated soil, large amounts of mine residuals, on-site residents, lack of access restriction, and use of the site for recreation. Removing the residents from the site eliminated the direct human exposure to the contaminants on the site.

The completed time-critical removal action has eliminated the migration of contaminants off-site and ensures that on-site visitors will not be exposed to contaminated surface soils. All contaminated soil on-site was consolidated into the tailings pile and capped with clean soil and vegetation. Physical and legal restrictions will prevent inappropriate use of the site and protect residents from future exposure to hazardous substances that will remain at the site after completion of the time-critical removal action (7).

The immediate risk of human exposure on-site has been reduced, and EPA now has the opportunity to study the surrounding area to determine further cleanup actions of the contaminants that have already migrated from the site.

Pathway Analysis

To determine whether residents of the area have been or are being exposed to contaminants from the ALM site, DHSS evaluated the environmental and human components that lead to an exposure pathway. Completed exposure pathways exist when all five elements of a pathway link

the contaminant source to a receptor population. Potential exposure pathways exist if at least one of the five elements is missing or uncertain, but could exist. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present. Completed and potential exposure pathways could have been present in the past, could be present currently, or could be present in the future (10). Appendix B, Table 6 lists the exposure pathways present at the ALM site.

1. **Contaminant source –** tailings piles and exposed ore in abandoned mines.
2. **Environmental medium and transport –** contaminated water and soil.
3. **Point of exposure –** private drinking wells, on-site residence, soil, and surface waters.
4. **Route of exposure –** ingestion and inhalation.
5. **Receptor population –** former residents, private well users and those who inhaled contaminated ambient air or ingested contaminated soil, or surface water.

Completed Exposure Pathways

Past:

In the past, exposures to contaminated materials occurred. The on-site residents were exposed to contamination in their residence, water, and soil surrounding the residence. In 1997, the children that resided on-site had elevated blood lead levels above 10 µg/dl. In response, EPA completed a removal action, which resulted in the removal and permanent relocation of the children and their immediate family from the site. During dry, windy weather conditions, nearby residents and visitors could have been exposed to contaminated air. Residents who drank from the contaminated on-site well were exposed to contaminated water. Residents who used Sutton Branch south of the ALM site could have been exposed to contaminated water and sediment in the creek.

Present

The time-critical removal action has been completed at the ALM site. While precautions were taken during the time-critical removal action to prevent soil from eroding into Sutton Branch Creek, contaminant migration has previously occurred. There is the potential for residents and recreational visitors south of Hwy 49 to be exposed to contaminated water or sediment in Sutton Branch.

Potential Exposure Pathways

In the past, there was potential for human exposure to contaminated ambient air. Releases of metal contaminated dusts likely occurred to the ambient air during windy periods. Several acres of unvegetated mining waste existed at the site. Additionally, driving vehicles over waste covered areas or dirt/chat gravel roads could have released dusts to the ambient air. Unvegetated areas and tailings piles with high permeability and low water capacity are prone to drifting with the blowing of material and caving episodically into intermittent drainages. During the 1996 SSI

and 1999 ESI/RA, the potential for release to the ambient air was considered high. However, no air sampling was conducted.

The completion of the time-critical removal action has eliminated the risk of migration of the contaminants to the ambient air. As activities associated with the time-critical removal action were being conducted at the site, water trucks were on-site to ensure the fugitive dust generated by the heavy equipment was kept to a minimum. The tailings pile was capped with clean soil that should allow vegetation to grow. The clean soil and vegetation will prevent the tailings from being exposed to the wind.

There have been reports that the tailings were used around the town of Annapolis for residential driveways, fill for roads, and as playground surface material. If the tailings have been redistributed, there is the potential for residents to be exposed to contaminated materials at their homes or around town.

Recent sampling indicates that the surface water and sediment in Big Creek in Sam A. Baker State Park do not have elevated levels of contaminants from the ALM site. However, it is not known whether parts of Sutton Branch and Big Creek further upstream and nearer to the ALM site still have elevated levels of contaminants. If these surface water bodies are contaminated, there is the potential for human exposure.

TOXICOLOGICAL EVALUATION

This section will discuss the potential adverse health effects of exposure to cadmium, lead, and zinc. An outline of health effects and the likelihood of the contaminants causing cancer will be evaluated. ATSDR has developed comparison values (CVs) that are media-specific concentrations used by health assessors to select environmental contaminants of concern. Contaminant concentrations that are less than the CV are unlikely to pose a health threat. Contaminant levels above the CV do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathways is needed. Environmental media evaluation guides (EMEGs) are CVs that have been derived for a variety of chemicals in various media. Minimal Risk Levels (MRLs) are an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncancer) over a specified duration of exposure. MRLs can be derived for acute, intermediate, and chronic duration exposures by the inhalation and oral routes. Acute exposure is defined as exposure that occurs for less than 14 days. Intermediate exposure occurs for more than 14 days but less than 364. Chronic exposure occurs for more than 365 days. The lowest observed adverse effect level (LOAEL) is the lowest tested dose of a substance that has been shown to cause harmful health effects in humans or animals. The no observable adverse effects level (NOAEL) is the highest dose of a chemical in a study or a group of studies that did not cause harmful health effects in people or animals.

Arsenic

Exposure to arsenic can occur by eating food, drinking water, or breathing air that is contaminated with arsenic. Children may be exposed to arsenic because of hand-to-mouth contact or eating contaminated dirt.

Large doses resulting from eating food or drinking water containing 60 ppm or more can produce death while eating food or drinking water containing lower levels (0.3 to 30 ppm) can cause irritation of the stomach and intestines. The symptoms will include stomachache, nausea, vomiting, and diarrhea (11). Swallowing inorganic arsenic might also cause decreased production of red and white blood cells which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a “pins and needles” sensation in your hands and feet (11).

Breathing high levels of inorganic arsenic is likely to cause a sore throat and irritated lungs. Inhaling large concentrations of arsenic contaminated air over long periods of time may cause lung cancer. Direct skin contact with inorganic arsenic compounds may cause skin irritation with redness and swelling but does not likely lead to serious internal effects (11). Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the lungs, bladder, liver, kidney, and prostate (11).

In the groundwater wells, arsenic was below public drinking water standards. Although the levels of arsenic found in on-site soil samples exceeded background values, they did not exceed health based comparison values. A worst-case scenario was evaluated for soil ingestion using the value found in soil adjacent to on-site residence (53.9 mg/kg) and assuming that all of the arsenic in the soil would accumulate in the body. The estimated contaminant dose for adults living on-site and incidentally ingesting soil is 0.000077 mg/kg/day and for children is 0.0011 mg/kg/day. The MRL established by ATSDR for chronic (occurring for more than one year) oral exposure to arsenic in soil is 0.0003 mg/kg/day. For chronic oral continuous exposure to arsenic, the LOAEL for non-cancer effects in humans is 0.014 mg/kg/day and the NOAEL is 0.0004 mg/kg/day. The LOAEL for cancer in humans is 0.022 mg/kg/day.

Because the estimated arsenic dose for children was more than the NOAEL, the level of arsenic in the soil could have presented a health concern for non-cancer health effects for past child residents if the soil was ingested on a continuous basis for a long-time period. However, it is unlikely that type of exposure occurred, and there are no longer residents living on-site. EPA has completed a time-critical removal action at the site, which consolidated and covered waste materials eliminating the potential for exposure. No adverse health effects are currently expected to occur from the arsenic levels at the ALM Site.

Cadmium

Cadmium is a soft, silver-white metal that occurs naturally in the earth’s crust. Cadmium is not usually present in the environment as a pure metal, but as a mineral combined with other elements. It is most often present in nature as complex oxides, sulfides, and carbonates in zinc,

lead, and copper ores (12). Cadmium has many industrial uses and consumer products, mainly in batteries, pigments, metal coatings, plastics, and some metal alloys.

Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death. Cadmium is a cumulative toxin and ingestion of lower levels for a long period of time can lead to a buildup of cadmium in the kidneys and, possibly, kidney damage. The kidney is the main target organ for cadmium toxicity following chronic exposure by oral routes (12).

The MRL for chronic ingestion of cadmium is 0.2 micrograms per kilogram per day (µg/kg/day) for adults. The current average dietary intake of adult Americans is approximately 0.4µg/kg/day and smokers intake about an equal amount from cigarettes (12). This indicates that Americans currently do not have a large margin of safety with respect to cadmium intake.

In Appendix C, the estimated contaminant doses for water and soil ingestion for adults and children were calculated. For water ingestion, the level detected at the potential on-site residence of 6.08 ug/L was used, the estimated contaminant dose for adults is 0.174 ug/kg/day and for children 0.608 ug/kg/day. Appendix C shows the complete calculations for the estimated contaminant doses for cadmium. The NOAEL for lifetime oral exposure to cadmium is 2.1 µg/kg/day. The chronic oral MRL for cadmium is 0.2 µg/kg/day. Because the worse case scenario estimated contaminant dose does not exceed the NOAEL or MRL, adverse health effects would not be expected. However, to be completely protective of public health if the drinking water was to be used by residents, the level of cadmium should be below EPA's MCL of 5 µg/L.

Although the levels of cadmium found in the on-site soil samples exceeded background values, they did not exceed health based comparison values. There are no longer residents living on-site and EPA has completed a time-critical removal action at the site, which consolidated and covered waste materials. No adverse health effects are expected to occur from the levels detected at the ALM Site.

Lead

Lead is a naturally occurring metal found in the earth's crust. It has no characteristic taste or smell. It is mined and processed for use in various industries. The practice of depositing mine tailings above ground has made a large volume of lead more accessible to people. It is used in some types of batteries, ammunition, ceramic glazes, medical equipment, scientific equipment, and military equipment. At one time, lead was used as an additive in gasoline and in paint. Lead was released into the air in automotive exhaust and deposited along roadways when it was in gasoline. Lead in the soils in the inner cities is often attributable to old houses on which lead based paint was applied (13).

Exposure to lead can occur by inhalation or ingestion and the effects on the body are the same. Lead is not readily absorbed through the skin, so dermal contact is not an important route of exposure. Lead has the greatest effect on the nervous system, in adults and especially in

children. In children, low levels of lead can cause weakness in fingers, wrists, or ankles. At high levels, lead can damage the brain and kidneys in adults and children. Pregnant women can experience miscarriage if exposed to high levels of lead (13).

Although EPA considers lead to be a B2 carcinogen (probable human carcinogen, inadequate human, sufficient animal studies), no studies in humans were found to indicate that inorganic lead was carcinogenic to humans after inhalation or ingestion exposure (13). The National Toxicity Program (NTP) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens based on limited evidence from studies in humans and sufficient evidence from studies in experimental animals (14).

EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) was used with site-specific soil concentrations to predict blood-lead concentrations for children exposed to lead contaminated soil at this site. The model calculates intakes of lead from site-specific lead concentrations in soil, house dust, air, water and food. When available, actual sampling data on lead in the various media at the site are used to calculate site-specific intake rates. Media-specific default values are used in the model if site-specific sampling data are not available. Once the intake values are calculated, the biokinetics of lead, or where the lead goes once inside the body and how quickly it is eliminated, are used to calculate an average blood lead concentration and the distribution of blood lead concentrations around that value within the population of concern. These results are then used to determine the probability that a child will have a blood lead concentration above a specific level.

Using the maximum value of lead found in the soil adjacent to the on-site residence (27,500 mg/kg) and default values for the other inputs, the model predicted that 99.9% of children who would be exposed to that soil would have elevated blood lead levels (>10 µg/dL). Using the mean value of lead detected during the 1996 SSI of 9059 mg/kg and default values for the other inputs, the model predicted that 99.7% of children exposed to that level of lead contamination would have elevated blood lead levels. The model accurately predicted the likelihood of elevated blood lead levels in children exposed to the contaminated soil. In 1997, the children who resided on-site had blood lead levels that ranged from 11 to 20 µg/dl.

In the past, the lead levels found in the soil and water exceeded lead action levels for soil and MCLs for water. Residents, especially children, were at risk for adverse health effects. The children who resided on-site did have elevated blood lead levels. However, there are no longer residents living on-site. The pile has been capped and vegetated, covering the contaminated soil. Exposure to the on-site lead has been significantly reduced or eliminated by the time-critical removal action and physical and legal restrictions.

Thallium

Thallium is a bluish-white metal that is found in the earth's crust. It is odorless and colorless when pure. It can also be found mixed with other metals in the form of alloys. Thallium remains in the environment and does not break down to other substances (15).

Exposure to thallium can occur by breathing contaminated air, drinking contaminated water, eating contaminated food, or skin contact with contaminated material. Plants easily uptake thallium through their roots. Cigarettes are also a source of thallium. When thallium is swallowed it is absorbed and rapidly goes to various parts of your body, especially the kidney and liver (15). Thallium can affect the nervous system, lungs, heart, liver, and kidneys if large amounts are consumed in a short time period. Exposure to large amounts of thallium for short periods of time can also cause temporary hair loss, vomiting, diarrhea, and even death.

It is not known if exposure to thallium may cause cancer in humans. In the past, the thallium levels found in the groundwater at the site exceeded MCLs for drinking water. If thallium contaminated water was used as a primary drinking water source, residents, especially children, could have been at risk for adverse health effects. Exposure to the on-site thallium should be eliminated by the physical and legal restrictions put in place at the site. The groundwater is no longer used as a drinking water source; therefore, adverse health effects are not expected.

Children's Health

In general, children are more likely than adults to be exposed to contaminants in soil or water. In their daily activities, children have a tendency for frequent hand-to-mouth contact and often introduce non-food items into their mouths. Because children are smaller and their bodies typically retain more of the contaminants, it usually takes less of a contaminant to cause adverse health effects in children than adults.

If the children who resided on-site ingested soil with high levels of arsenic, they would be likely to have many of the same effects as adults. These health effects could include irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function (11). There is some evidence suggesting that children may be less efficient at converting inorganic arsenic to the less harmful organic forms. Therefore, children may be more susceptible to health effects from inorganic arsenic than adults.

The effects of exposure to elevated levels of cadmium on children are expected to be similar to the effects on adults. Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death (12). Ingestion to lower levels of cadmium over an extended period of time can lead to buildup in the kidneys, and possibly, kidney damage. The values of cadmium detected in the water from the potential on-site residence would be of a concern if children consumed water from their residential drinking water wells with these levels of cadmium for several years, adverse health effects may occur. The level of cadmium in the soil does not appear to present a health concern for residents.

Children are more susceptible to lead poisoning than adults and are more likely to be exposed to lead contaminated materials. Babies and children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. Also, compared to adults, a bigger proportion of the amount of lead swallowed will enter the blood in children (13). While about 99% of the amount of lead taken into the body of an adult will leave as waste within few weeks, only about 32% of

lead taken into the body of a child will leave as waste (13). This allows for accumulation of lead in the child's system. When children are exposed to lead contaminated materials, a variety of adverse health effects can occur depending on the level of lead to which they are exposed and the duration of exposure. These effects include learning disabilities, slowed growth, hyperactivity, impaired hearing, and at very high exposure levels, even brain damage (13). Unborn children can also be exposed to lead through their mothers and are at risk of premature birth, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children (13).

For children, the predicted 95th percentile blood lead level associated with a soil lead concentration of 340 mg/kg is approximately 10 µg/dl (16). Therefore, children who are regularly exposed to soil lead levels of 340 mg/kg should have no more than a 5% probability of having blood lead levels greater than 10 µg/dl (16). As stated earlier, EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) estimated that children exposed to lead contaminated soil at this site would have an increased risk of having an elevated blood lead level. Using the maximum value of lead found in the soil adjacent to the on-site residence (27,500 mg/kg) and default values for the other inputs, the model predicted that 99.9% of children who would be exposed to that soil would have elevated blood lead levels. Using the mean value of lead detected during the 1996 SSI of 9059 mg/kg and default values for the other inputs, the model predicted that 99.7% of children exposed to that level of lead contamination would have elevated blood lead levels.

Blood lead levels as low as 10 µg/dl are associated with learning difficulties in children. Regular blood-lead testing before a child is six years old is key to determining if the child has been exposed. Eliminating exposure pathways by controlling contamination sources, practicing good personal hygiene, and eating a proper diet can prevent lead poisoning in children. The emphasis of blood-lead testing is on children six years old and younger who are the most susceptible to blood-lead poisoning.

Animal data does suggest that thallium is a developmental toxicant, but it does not allow for a conclusion about the effects on human children. Other health effects are expected to be similar for children.

COMMUNITY HEALTH CONCERNS

Recently, there has been some community concern that the water, soil, and sediment of Big Creek in Sam A. Baker State Park have been affected by the contaminated runoff from the ALM site. Residents of the area and visitors to the park were concerned that arsenic, cadmium, lead, thallium, and zinc could be leaching out of the tailings pile at the ALM site and contaminating the water, sediment, and soil of Big Creek. MDNR addressed these comments at a public meeting in Annapolis by discussing the sampling that was completed at Sam A. Baker State Park in May 2004.

Nearby residents are aware of the current DHSS fish advisory warning against eating sunfish because of lead concentrations from Big Creek near the town of Glover, which is eight miles north and upstream of Annapolis and 30 miles from Sam A. Baker State Park. The residents are concerned that the fish in Big Creek further downstream would also be unsafe to eat. These concerns were voiced at a public meeting in Annapolis. EPA's On Scene Coordinator responded to the concerns and explained that the fish advisory is in the portion of Big Creek north of the site. He also stated that at that time there was no reason to think that the fish in the area of Big Creek near Annapolis would be unsafe to eat. He explained that the remedial investigation would examine the spread of contaminants from the ALM site into Sutton Branch Creek and Big Creek that occurred before the removal action was completed.

A few Annapolis residents have expressed concern about possible lead contamination in their residential yard soils. EPA sampled 16 residential yards within the town of Annapolis. Fourteen of the yards did not have lead at levels of concern. Two yards had elevated levels of lead but were not significant enough to warrant removal action. EPA informed residents of the sampling results and answered related questions.

The public comment version of the Annapolis Lead Mine Site Public Health Assessment was released for public comment on October 11, 2005, with the public comment period ending on November 28, 2005. On November 8, 2005, DHSS held a public availability session to present the public comment version of the Annapolis Lead Mine Site Public Health Assessment. At that time and during the public comment period, the public had the opportunity to ask questions or express concerns regarding the site and the public health assessment.

No community members attended the public availability session or submitted comments during the public comment period. DHSS did not receive any comments on the public comment version of the Annapolis Lead Mine Site Public Health Assessment during the public comment period.

HEALTH OUTCOME DATA

Because the health effect of most concern at this site was elevated blood lead levels in children, the health outcome data that was evaluated was child blood lead data. During 1997, the children that resided on-site had their blood analyzed for lead several times. The levels ranged from 11 micrograms per deciliter (µg/dl) to 20 µg/dl. However, the exposure was eliminated by permanently relocating the children and their immediate family from the site.

According to the 2000 U.S. Census, there are 81 children under 72 months in the Annapolis zip code (63620). Blood lead data for the 63620 zip code were reviewed to determine the number of tests administered and children with elevated blood lead. From January 2000 through July 2005, a total of 132 tests were administered with no elevated results.

CONCLUSIONS

Environmental sampling results and blood lead testing indicated that in the past, on-site residents were exposed to cadmium and lead at levels of health concern.

Because residents were living on-site, contaminants were present at levels exceeding health concern, and the on-site residents did have elevated blood lead levels, the ALM site is considered to be a *Public Health Hazard* for past exposures. This classification is for sites that pose a serious risk to public health as the result of long-term exposures to hazardous substances.

EPA has completed a time-critical removal action at the site, which consolidated and covered waste materials on-site. As a result, the migration of contaminants from the site has been eliminated, except possibly percolation of water through the mine tailings pile into groundwater or surface water. The completion of the time-critical removal action makes the tailings pile area fairly stable and less of a physical hazard. Several old mine building foundations will be left on-site in various stages of deterioration. They could be unstable and prone to collapse, causing a potential physical hazard to those on-site. Physical and legal restrictions are in place as part of EPA's actions to prohibit activities at the site that would cause exposure to contaminants to occur.

The ALM on-site area is considered to be a *No Apparent Public Health Hazard* for present and future exposures. This classification is for sites where human exposure to contamination is occurring or has occurred in the past, but the exposure is not likely to result in adverse health effects.

The off-site area surrounding the ALM site, including the town of Annapolis and the Sutton Branch Creek south of Hwy 49, may have been affected by migration of contamination. A migration study is planned, and if appropriate, a removal action will be done. However, because levels of contaminants in Sutton Branch Creek and Annapolis are unknown, these areas are considered to be an *Indeterminate Public Health Hazard* for present and future exposures. This classification is for sites for which there is incomplete information.

RECOMMENDATIONS

1. The former mine building that served as a residence should remain uninhabited.

2. EPA/MDNR should inspect the capped tailings pile annually to ensure that vegetation grows to further stabilize the pile and prevent erosion.

3. EPA/MDNR should institute physical and legal restrictions for the site property to prohibit digging or other activities that may result in exposure to the remaining hazardous substances.

4. EPA/MDNR should continue monitoring contaminant levels of Sutton Branch, Big Creek, and the St. Francois River.

5. EPA should conduct additional sampling in the area surrounding the site, including in the town of Annapolis, to determine if contamination is present. Additional downstream sediment characterization is needed to assess impact from material transported downstream from the site. If contamination is found, the likelihood of exposure and the necessity of further actions should be determined.

6. MDNR/ Missouri Department of Conservation should sample fish from Sutton Branch, Big Creek, and the St. Francois River to test for heavy metals accumulation.

PUBLIC HEALTH ACTION PLAN

This Public Health Action Plan (PHAP) for the ALM site contains a description of actions to be taken by the Missouri Department of Health and Senior Services (DHSS), the federal Agency for Toxic Substances and Disease Registry (ATSDR), and other stakeholders. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and future exposures to hazardous substances at or near the site. Below is a list of commitments of public health actions to be implemented by DHSS, ATSDR, or other stakeholders at the site:

1. DHSS/ATSDR will coordinate with the appropriate agencies or stakeholders to implement the recommendations in this public health assessment.

2. DHSS/ATSDR will assist other agencies in addressing community health concerns and questions as they arise at public meetings.

3. DHSS/ATSDR has provided and will continue to provide the community with health education at public meetings that have been held in Annapolis.

4. DHSS/ATSDR will evaluate additional data related to contaminant levels in Sutton Branch Creek and Annapolis and will reevaluate the hazard posed by this site.

5. DHSS/ATSDR will coordinate with the appropriate agencies to assist with education of the public as to the dangers of lead poisoning.

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CERTIFICATION

This Annapolis Lead Mine site, Annapolis, Missouri, Public Health Assessment was prepared by the Missouri Department of Health and Senior Services (DHSS) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with the approved methodologies and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Team Lead, CAT, CAPEB, DHAC, ATSDR

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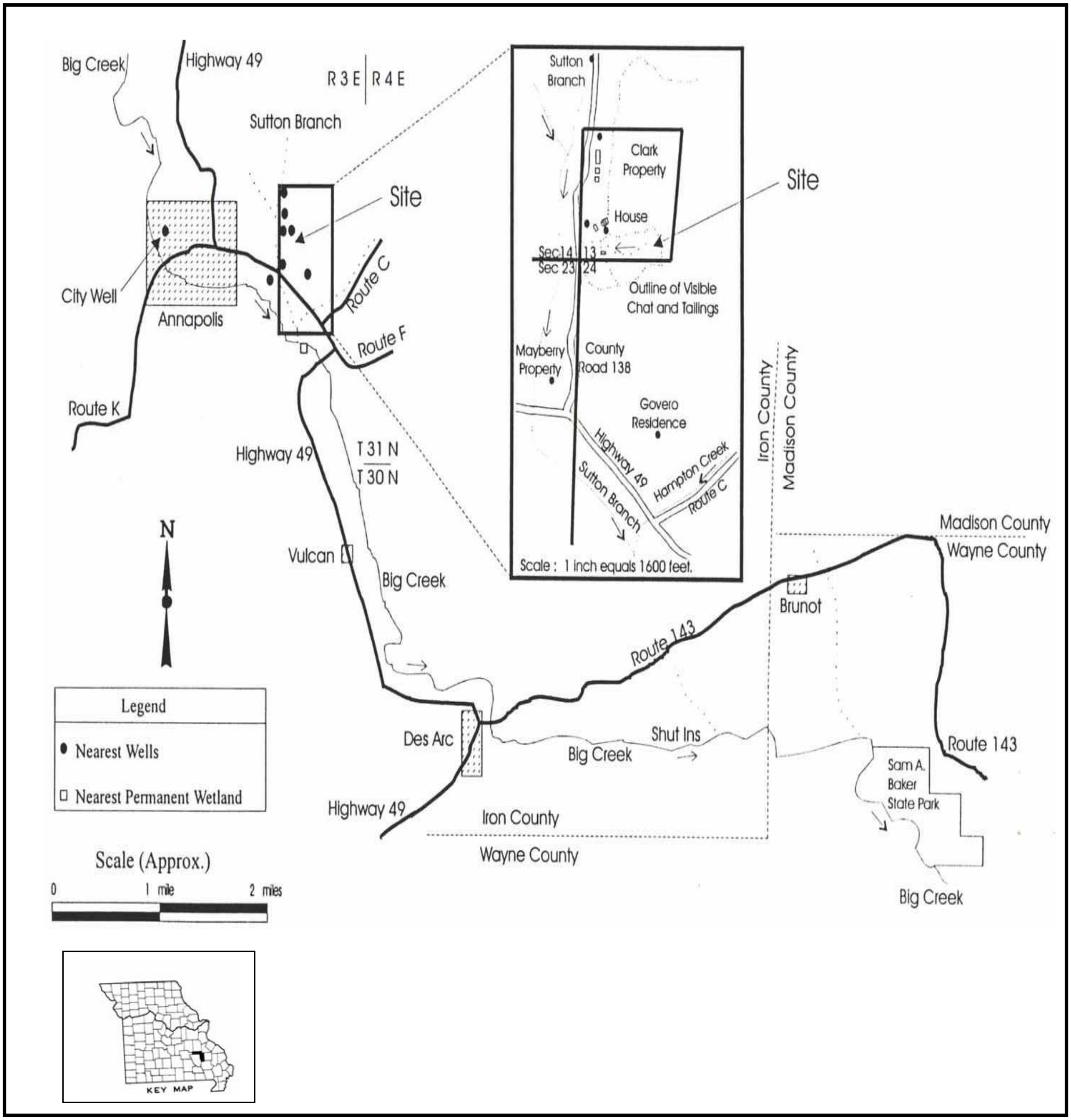
Appendix A: Figures

Figure 1

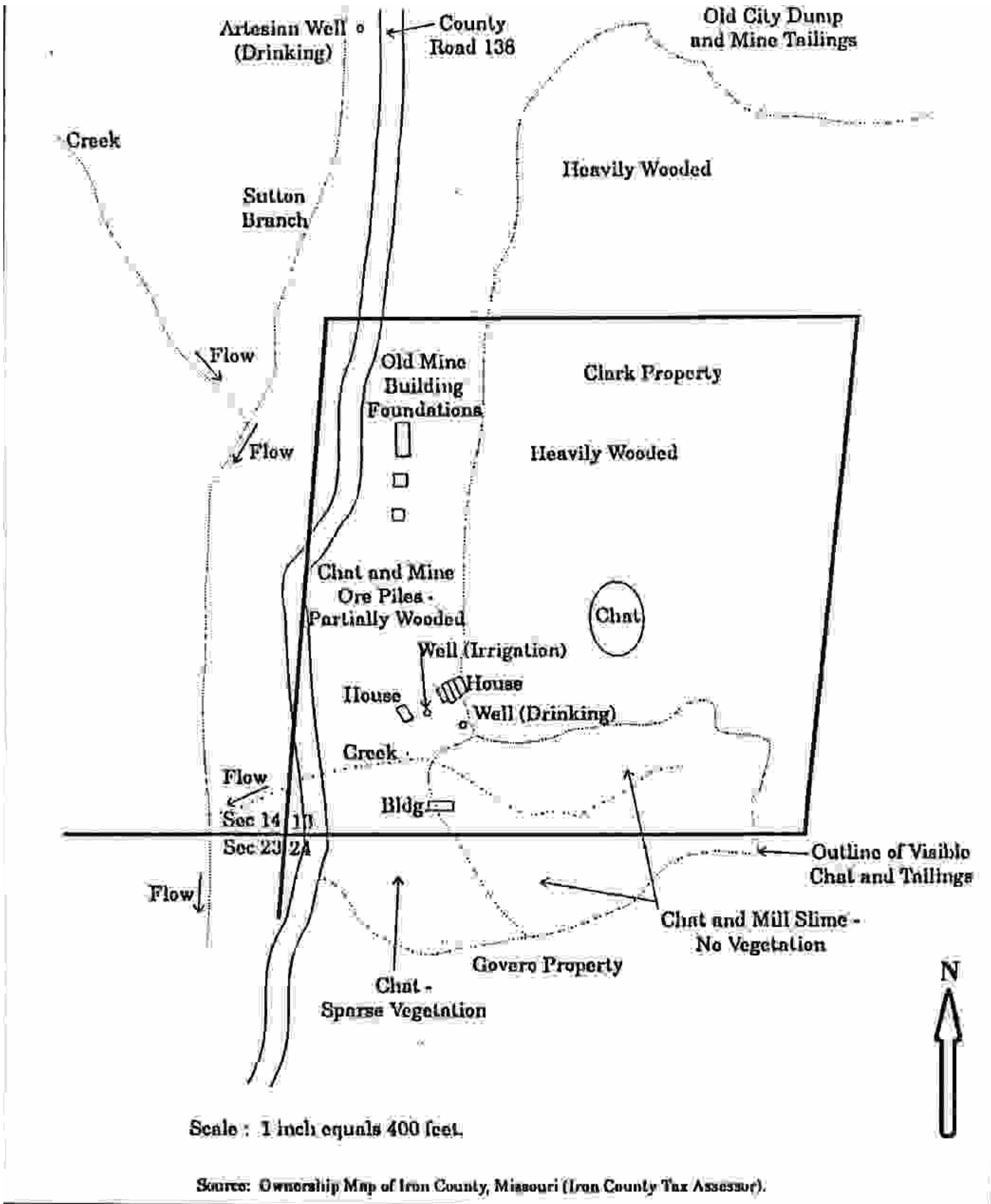
Annapolis Lead Mine Site Area Map, Iron County, Missouri



Modified from: Sverdrup Environmental. Draft Screening Site Inspection Report for the former Annapolis Lead Mine Site in Annapolis, Missouri. 1996 June 20.

Figure 2

Map of Annapolis Lead Mine Site (August 1995), Iron County, Missouri



Source: U.S. Environmental Protection Agency. Preliminary Assessment for Site Assessment Activity at Annapolis Lead Mine Site. Annapolis, Missouri. 1995 August 2.

Appendix B: Tables

Table 1

Groundwater Analysis Summary from 1996 Screening Site Inspection, Annapolis Lead Mine Site

Contaminant	Shallow Irrigation (µg/L)	Shallow Irrigation (Duplicate) (µg/L)	On-site Residence (µg/L)	Artesian (µg/L)	Potential On-site Residence (µg/L)	MCL/AL (µg/L)
Arsenic	2.6	1.9	1.66U	1.66U	1.66U	50
Cadmium	3.69U	3.69U	3.69U	3.69U	**6.08**	5
Chromium	14.2U	14.2U	14.2U	14.2U	14.2U	100
Copper	8.32U	8.32U	8.32U	8.32U	13.9	1,300
Iron	**2490**	**3590**	65.9U	65.9U	**41,500**	300
Lead	**40.3**	**40.8**	2.8	2.5	3.8	15
Nickel	11.5U	11.5U	11.5U	11.5U	43.5	100
Silver	7.88U	7.88U	7.88U	7.88U	7.88U	100
Thallium	**2**	**3.2**	**1.8**	**2.3**	**2**	0.5
Zinc	1,210	1,270	36.8	10.8U	27	5,000

The 1996 Site Screening Inspection was conducted by the US Environmental Protection Agency.
MCL= Maximum Contaminant Level
AL= Action Level (for Copper and Lead, MCLs are not available)
Boldface type denotes a value that exceeds specific MCL or AL.

Table 2

On- Site Soil Analysis Summary from 1996 Screening Site Inspection, Annapolis Lead Mine Site

Contaminant	CC104-100 (mg/kg)	CC104-100D (mg/kg)	CC104-101 (mg/kg)	CC104-102 (mg/kg)	CC104-103 (mg/kg)	CC104-104 (mg/kg)	CC104-105 (mg/kg)	CC104-111 (mg/kg)	CC104-112 (mg/kg)	Background Level (mg/kg)	3 times Background Level
Arsenic	**113**	**74**	**7.93**	**44.6**	**59**	**41.4**	**36.7**	0.95U	**53.9**	0.95	2.85
Cadmium	**9.54**	**7.74**	4.67	2.48	3.89	3.24	3.16	1.77	**10.9**	1.77	5.31
Chromium	1.89	2.05	0.908U	1.44	1.15	1.57	4.18	15	5.81	15	45
Copper	**138**	**113**	26.3	**92.3**	42.3	**98.7**	**94.5**	16.8	**266**	16.8	50.4
Lead	**28300**	**14800**	**1330**	**971**	**2570**	**3140**	**2620**	300	**27500**	300	900
Nickel	**56**	**48.1**	7.14	37.8	43.6	**45**	25.4	14.6	**45.5**	14.6	43.8
Silver	**2.67**	**2.36**	1.1	1.22	1.76	1.22	0.985	0.615U	**2.27**	0.615	1.845
Thallium	**22.9**	**21.0**	**20.1**	**25.8**	**24.9**	**24.7**	**19.8**	3.15U	**23.7**	3.15	9.45
Zinc	**676**	**523**	241	82.1	168	191	**336**	93.3	**776**	93.3	279.9

The 1996 Site Screening Inspection was conducted by the US Environmental Protection Agency.
All values in milligram per kilogram (mg/kg).
U=denotes values under the detection limit for EPA Laboratory analysis.

Table 3

Off-Site Surface Water and Sediment Analysis Summary from 1996 Screening Site Inspection, Annapolis Lead Mine Site

Surface Water Samples

Contaminant	Downstream (µg/L)	PPE (µg/L)	Upstream (µg/L)	AWQC/AALAC
Arsenic	1.66U	1.66U	1.66U	N/A
Cadmium	3.69U	3.69U	3.69U	1.1
Chromium	14.2U	14.2U	14.2U	N/A
Copper	8.32U	8.32U	8.32U	12
Lead	11.6	5.1	1.4	3.2
Nickel	11.5U	11.5U	11.5U	160
Silver	7.88U	7.88U	7.88U	2.3
Zinc	10.8U	10.8U	10.8U	110

Sediment Samples

Contaminant	Downstream (mg/kg)	PPE (mg/kg)	Upstream (mg/kg)	AWQC/AALAC
Arsenic	68.3	43.4	1.86	N/A
Cadmium	3.41	2.74	1.04	1.1
Chromium	1.3	1.31	9.43	N/A
Copper	62.6	45.7	5.5	12
Lead	3970	1300	13	3.2
Nickel	48.6	33.4	4.32	160
Silver	1.43	1.2	0.615U	2.3
Thallium	27.8	58.8	5.53	
Zinc	170	122	15.3	110

The 1996 Site Screening Inspection was conducted by the US Environmental Protection Agency.
PPE= Probable Point of Entry
AWQC=Ambient Water Quality Criteria
AALAC=Ambient Air Life Advisory Concentration
U= denotes values under the detection limit for EPA Laboratory analysis.

Table 4

On-Site Waste/Soil Sample Results from 1999 Expanded Site Inspection/Removal Assessment, Annapolis Lead Mine Site

Sample #	Sample Depth	Arsenic (mg/kg)	Cadmium (mg/kg)	Cobalt (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
Outwash Area									
-306	0-6 inches	12	2.0	15	13	36	23	**470**	190
-308	0-6 inches	**60**	1.8	60	8.5	160	59	**1,100**	220
-310	0-6 inches	**53**	4.9	36	2.5	130	29	**1,700**	320
-312	6-12 inches	12	2.3	11	24	28	26	130	170
-317	0-6 inches	**32**	3.4	30	0.94	93	19	**1,300**	200
-318	0-6 inches	**35**	1.9	60	1.7	96	44	**1,000**	170
Former Mining Area									
-300	0-6 inches	**85**	7.7	51	15	200	51	**20,000**	740
-301	0-6 inches	**71**	2	81	17	170	69	**3,200**	180
-302	0-6 inches	22	1	31	12	55	29	**3,300**	180
-303	0-6 inches	5.9	0.23U	18	13	10	13	68	41
-304	0-6 inches	4.6	0.4	7.9	20	17	18	83	66
-305	0-6 inches	25	1.9	14	13	37	25	**410**	270
-307	0-6 inches	13	0.5	18	20	21	18	210	68
-311	6-12 inches	5.4	0.23U	17	8.4	12	19	24	40
Mill Slime Pond									
-309	6-12 inches	**64**	2.1	67	4.7	86	55	**7,000**	160
Background									
-313	0-6 inches	7.5	0.23U	14	59	10	13	29	26
-314	0-6 inches	9.6	0.56	16	19	12	12	74	46
-315	0-6 inches	5.7	0.47	6.3	4.7	14	6.5	100	39
-316	6-12 inches	11	0.23	91	34	39	39	24	58
Health Based References									
EPA Reference Dose		23.0	39.0	N/A	3,900	N/A	1,600	N/A	23,000
Region 3 RBCs for Residential Soil		23.0	39.0	4,700	390	2,900	N/A	400	23,000
ATSDR Comparison Values		20 (child, chronic)	10 (child, chronic)	500 (child, intermediate)	N/A	500 (child, intermediate)	1000 (child, RMEG)	N/A	20,000 (child, chronic)

The 1999 Expanded Site Inspection/Removal Assessment was conducted by the US Environmental Protection Agency.
U=denotes value that is under detection limit for analysis.
N/A=no reference was available.
Bold face type denotes values that are above health-based benchmarks.
RMEG=Reference Dose Media Evaluation Guide.

RBC=Risk Based Concentrations
Chronic =exposure that occurs for more than one year.
Intermediate=exposure that occurs for more than 14days but less than one year.

Table 5

Monitoring Results from Surface Runoff Outfall, Annapolis Lead Mine Site

Contaminant (mg/L)	Date	Daily Maximum	Monthly Average	Water Quality Criteria (mg/L)		MCL (mg/L)	ATSDR Comparison Value EMEG (mg/L)
				CMC	CCC		
Arsenic	7/7/04	0.0031	0.0031	0.34	0.15	0.010	0.003 (child, chronic) 0.01 (adult, chronic)
Cadmium	7/7/04	ND	ND	0.0046	0.0022	0.005	0.002 (child, chronic) 0.007 (adult, chronic)
Chromium	7/7/04	ND	ND	0.57*	0.074*	0.1	‡0.1
Copper	7/7/04	ND	ND	0.013	0.009	†1.3	0.3 (child, intermediate) 1.0 (adult, intermediate)
Lead	7/7/04	0.0456	0.0456	0.065	0.0025	†0.015	NA
Nickel	7/7/04	ND	ND	0.47	0.052		§0.2 (child) §0.7 (adult)
Thallium	7/7/04	ND	ND	-	-	0.002	‡0.0005
Zinc	7/7/04	0.12	0.12	0.12	0.12	†3	3 (child, chronic) 10 (adult, chronic)

These results were supplied by the US Environmental Protection Agency.
mg/L= milligrams per liter.
CMC= Criteria Maximum Concentration.
CCC= Criteria Continuous Concentration.
MCL= Maximum Contaminant Level.
ND= concentrations below method detection limits.
*Water Quality criteria listed for Chromium.
†EPA Action Level, MCL not available.
ATSDR=Agency for Toxic Substances and Disease Registry.
EMEG=Environmental Media Evaluation Guide.
Acute=Exposure that occurs for less than 14 days.
Intermediate=Exposure that occurs for more than 15 days but less than one year.
Chronic= Exposure that occurs for more than one year.
‡LTHA= Lifetime Health Advisory for drinking water (EPA).
§RMEG= Reference Dose Media Evaluation Guide.
NA=not available.

Table 6

Exposure Pathway Analysis, Annapolis Lead Mine Site

Pathway Name	Exposure Pathway Elements					Time
	Source	**Environmental Medium**	**Point of Exposure**	**Route of Exposure**	**Exposed Population**	
Groundwater	Tailings and chat piles, contaminated soil	Groundwater	Private drinking wells	Ingestion	Residents around the Annapolis Lead Mine site	Past Present Future
Soil	Tailings	Surface Soil	Residential yards	Ingestion and inhalation	Residents around the Annapolis Lead Mine site	Past Present
Fish	Tailings	Surface Water	Residences or cookouts	Ingestion	Residents who eat fish from Big Creek	Past Present Future

Appendix C

Calculations

Appendix C

Contaminant Dose Estimations

Equation used for Estimating Water Ingestion Exposure Dose:

$$ID_w = \frac{C \times IR \times EF}{BW}$$

where: ID_w = Ingestion Exposure Dose [milligram per kilogram per day (mg/kg/day)]
C = Contaminant Concentration (mg/L)
IR = Ingestion Rate (default of 2 L/day for adult, 1 L/day for child)
EF = Exposure Factor [amount of time exposed (assume 100% of the time, value = 1)]
BW = Body Weight (default of 70 kg for adult and 10 kg for child)

Cadmium

Value found at potential on-site residence (6.08 µg/L or 0.00608 mg/L)

Adult

$$ID_w = \frac{0.00608 \text{ mg/L} \times 2 \text{ L/day} \times 1}{70 \text{ kg}}$$

ID_w = 0.000174 mg/kg/day

Child

$$ID_w = \frac{0.00608 \text{ mg/L} \times 1 \text{ L/day} \times 1}{10 \text{ kg}}$$

ID_w = 0.000608 mg/kg/day

Minimal Risk Level (MRL) established by ATSDR for Chronic (occurring for more than one year) Oral Exposure to Cadmium in drinking water is 0.0002 mg/kg/day.

Equation used for Estimating Soil Ingestion Exposure Dose

$$ID_s = \frac{C \times IR \times EF \times CF}{BW}$$

where: ID_s = Soil Ingestion Exposure Dose [milligram per kilogram per day (mg/kg/day)]
C = Contaminant Concentration (mg/L)
IR = Soil Ingestion Rate (default of 100 mg/day for adult, 200 mg/day for child)
EF = Exposure Factor [amount of time exposed (assume 100% of the time, value = 1)]
CF = Conversion Factor (10^{-6} kg/mg)
BW = Body Weight (default of 70 kg for adult and 10 kg for child)

Arsenic

Maximum Value found in soil adjacent to on-site residence (53.9 mg/kg).

Adult

$$ID_s = \frac{53.9 \text{ mg/kg} \times 100 \text{ mg/day} \times 1 \times 10^{-6} \text{ kg/mg}}{70 \text{ kg}}$$

$ID_s = 7.7 \times 10^{-5}$ mg/kg/day

Child

$$ID_s = \frac{53.9 \text{ mg/kg} \times 200 \text{ mg/day} \times 1 \times 10^{-6} \text{ kg/mg}}{10 \text{ kg}}$$

$ID_s = 1.1 \times 10^{-3}$ mg/kg/day

Minimal Risk Level (MRL) established by ATSDR for Chronic (occurring for more than one year) Oral Exposure to Arsenic in soil is 0.0003 mg/kg/day.

Lead

Maximum Value found in soil adjacent to on-site residence (27,500 mg/kg).

Adult

$$ID_s = \frac{27500 \text{ mg/kg} \times 100 \text{ mg/day} \times 1 \times 10^{-6} \text{ kg/mg}}{70 \text{ kg}}$$

ID_s = 0.039 mg/kg/day

Child

$$ID_s = \frac{27500 \text{ mg/kg} \times 200 \text{ mg/day} \times 1 \times 10^{-6} \text{ kg/mg}}{10 \text{ kg}}$$

ID_s = 0.55 mg/kg/day

Mean value found in soil (9,059 mg/kg)

Adult

$$ID_s = \frac{9059 \text{ mg/kg} \times 100 \text{ mg/day} \times 1 \times 10^{-6} \text{ kg/mg}}{70 \text{ kg}}$$

ID_s = 0.013 mg/kg/day

Child

$$ID_s = \frac{9059 \text{ mg/kg} \times 200 \text{ mg/day} \times 1 \times 10^{-6} \text{ kg/mg}}{10 \text{ kg}}$$

ID_s = 0.18 mg/kg/day

	Range of Total Estimated Dose (mg/kg/day)	**Range of Predicted Average Blood Lead Level (µg/dL)**	**Percent Predicted to have Blood lead level >10 µg/dL**
Child (max value)	**169-277**	**57-85**	**99.9**
Child (mean value)	**81-135**	**31-44**	**99.8**

For a child less than 72 months of age, a blood lead level above 10 µg/dL is considered to be elevated.

Appendix D. Glossary

ATSDR Glossary of Terms

General Terms

Absorption The process of taking in, as when a sponge takes up water. Chemicals can be absorbed through the skin into the bloodstream and then transported to other organs. Chemicals can also be absorbed into the bloodstream after breathing or swallowing.

Acute Occurring over a short time, usually a few minutes or hours. An *acute* exposure can result in short-term or long-term health effects. An *acute* effect happens a short time (up to 1 year) after exposure.

Adverse Health Effect A change in body function or the structures of cells that can lead to disease or health problems.

Ambient Surrounding. For example, *ambient* air is usually outdoor air (as opposed to indoor air).

ATSDR The Agency for Toxic Substances and Disease Registry. ATSDR is a federal health agency located in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Background Level A typical or average level of a chemical in the environment. *Background* often refers to naturally occurring or uncontaminated levels.

Biological Uptake The transfer of hazardous substances from the environment to plants, animals, and humans. This may be evaluated through environmental measurements, such as measurement of the amount of the substance in an organ known to be susceptible to that substance. More commonly, biological dose measurements are used to determine whether exposure has occurred. The presence of a contaminant, or its metabolite, in human biologic specimens, such as blood, hair, or urine, is used to confirm exposure and can be an independent variable in evaluating the relationship between the exposure and any observed adverse health effects.

Cancer A group of diseases that occur when cells in the body become abnormal and grow, or multiply, out of control.

Carcinogen Any substance that may produce cancer.

CERCLA The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund. CERCLA was enacted in 1980. It is also known as Superfund. This act concerns the release of hazardous substances into the environment and the cleanup of these substances and hazardous waste sites. This is the legislation that created ATSDR.

Chronic Occurring over a long period of time (more than 1 year).

Comparison Values Estimated contaminant concentrations in specific media that are not likely to cause adverse health effects, given a standard daily ingestion rate and standard body weight. The *comparison values* are calculated from the scientific literature available on exposure and health effects.

Concern The belief or worry that chemicals in the environment might cause harm to people.

Concentration The amount of a substance present in soil, water, air or food.

Contaminant Any substance or material that enters a system (the environment, human body, food, etc.) where it is not normally found.

Delayed Health Effect A disease or injury that happens as a result of exposures that may have occurred far in the past.

Dermal Referring to the skin. *Dermal* absorption means absorption through the skin.

Dose The amount of substance to which a person is exposed. *Dose* often takes body weight into account.

Duration The period of time (days, months, years) that a person is exposed to a chemical.

Environmental Contamination The presence of hazardous substances in the environment above the background level. From the public health perspective, *environmental contamination* is addressed when it potentially affects the health and quality of life of people living and working near the contamination.

Environmental Media Usually refers to air, water and soil in which chemicals of interest are found. Sometimes, plants and animals that are eaten by people are included.

EPA Environmental Protection Agency. The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Exposure Contact with a chemical by swallowing, breathing, or direct contact (such as through the skin or eyes). *Exposure* may be short term (acute) or long term (chronic).

Exposure Assessment The process of finding the ways people come into contact with chemicals, how often, and how long they come in contact with chemicals and the amounts of chemicals with which they come into contact.

Exposure Pathways A description o f the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having five parts:

1. Source of contamination
2. Environmental Media and Transport Mechanism
3. Point of exposure
4. Route of exposure
5. Receptor population.

When all five parts of an exposure pathway are present, it is called a Completed Exposure Pathway.

Exposure Registry A system for collecting and maintaining in a structured record, information on persons with documented environmental exposure(s). The *exposure registry* evolved from the need for fundamental information concerning the potential impact on human health of long-term exposure to low and moderate levels of hazardous substances.

Frequency How often a person is exposed to a chemical over time; for example, daily, once a week, once a month.

Hazard A source of risk that does not necessarily imply potential for occurrence. A hazard produces risk only if an exposure pathway exists, and if exposures create the possibility of adverse consequences.

Hazardous Waste Substances that have been released or thrown away into the environment and that under certain conditions, could be harmful to people who come into contact with them.

Health Consultation A response to a specific question or request for information pertaining to a hazardous substance or facility (which includes waste sites). It often contains a time-critical element that necessitates a rapid response; therefore, it is a more limited response than an assessment.

Health Education A program of activities to promote health and provide information and training about hazardous substances in the environment that will result in the reduction of exposure, illness, or disease. This program--both national and site-specific in focus--includes diagnosis and treatment information for health care providers and activities in communities to enable

them to prevent or mitigate the health effects from exposure to hazardous substances at hazardous waste sites.

Health Outcome Data A major source of data for public health assessments. The identification, review, and evaluation of health outcome parameters are interactive processes involving the health assessors, data source generators, and the local community. *Health outcome data* are community specific and may be derived from databases at the local, state, and national levels, as well as from data collected by private health care organizations and professional institutions and associations. Databases to be considered include morbidity and mortality data, birth statistics, medical records, tumor and disease registries, surveillance data, and previously conducted health studies.

Health Professional Education Any activity or activities directed toward public health professionals and the local medical community. The purpose of this activity is to improve the knowledge, skill, and behavior of health professionals concerning medical surveillance, screening, and methods of diagnosing, treating, and preventing injury or disease related to exposure to hazardous substances. These activities may include immediately disseminating written materials or making database information available, presenting workshops and short courses, or, where appropriate, long-term follow-up activities.

Indeterminate Public Health Hazard This category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion Swallowing (such as eating or drinking). Chemicals can get in or on food, drink, utensils, cigarettes, or hands where they can be ingested. After *ingestion*, chemicals can be absorbed into the blood and distributed throughout the body.

Inhalation Breathing. Exposure may occur from inhaling contaminants because they can be deposited in the lungs, taken into the blood, or both.

In situ In the original position.

Karst An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams, and caverns.

LOAEL Lowest Observable Adverse Effects Level. The lowest dose of a chemical in a study or a group of studies that has caused harmful health effects in people or animals.

MCL Maximum Contaminant Level The highest level of a contaminant that EPA allows in a public drinking water system. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible.

Media Soil, water, air, plants, animals, or any other parts of the environment that can contain contaminants.

Minimal Risk Level (MRL) An *MRL* is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncancer) over a specified duration of exposure. *MRLs* are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration via a given route of exposure. *MRLs* are based on noncancer health effects only. *MRLs* can be derived for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.

MDNR Missouri Department of Natural Resources.

National Priorities List (NPL) The Environmental Protection Agency's (EPA) listing of sites that have undergone preliminary assessment and site inspection to determine which locations pose

immediate threat to persons living or working near the release. These sites are most in need of cleanup.

National Toxicology Program (NTP) *NTP* conducts toxicological testing on those substances most frequently found at sites on the National Priorities List of the EPA, and which also have the greatest potential for human exposure.

NOAEL No Observable Adverse Effects Level. The highest dose of a chemical in a study or a group of studies that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.

No Public Health Hazard Sites for which data indicate no current or past exposure or no potential for exposure and therefore no health hazard.

Petitioned Public Health Assessment A public health assessment conducted at the request of a member of the public. When a petition is received, a team of environmental and health scientists is assigned to gather information to ascertain, using standard public health criteria, whether there is a reasonable basis for conducting a public health assessment. Once ATSDR confirms that a public health assessment is needed, the *petitioned health assessment* process is essentially the same as the public health assessment process.

Plume An area of chemicals in a particular medium, such as air or groundwater, moving away from its source in a long band or column. A *plume* can be a column of smoke from a chimney or chemicals moving with groundwater.

Point of Exposure The place where someone can come into contact with a contaminated environmental medium (air, soil, water or food).

Population A group of people living in a certain area, or, the number of people living in a given area.

Potential/Indeterminate Public Health Hazard Sites for which no conclusions about public health hazard can be made because data are lacking.

Potentially Exposed The condition where valid information, usually analytical environmental data, indicates the presence of contaminant(s) of a public health concern in one or more environmental media contacting humans (i.e., air, drinking water, soil, food chain, surface water), and there is evidence that some of those persons have an identified route(s) of exposure (i.e., drinking contaminated water, breathing contaminated air, having contact with contaminated soil, or eating contaminated food).

PRP Potentially Responsible Party A company, government or person that may be responsible for causing contamination at a hazardous waste site. PRPs are expected to help pay for the cleanup of a site.

Public Availability Session An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public Comment An opportunity for the general public to comment on Agency findings or proposed activities. The public health assessment process, for example, includes the opportunity for public comment as the last step in the draft phase. The purposes of this activity are to 1) provide the public, particularly the community associated with a site, the opportunity to comment on the public health findings contained in the public health assessment, 2) evaluate whether the community health concerns have been adequately addressed, and 3) provide ATSDR with additional information.

Public Health Action Designed to prevent exposures and/or to mitigate or prevent adverse health effects in populations living near hazardous waste sites or releases. Public health actions can be identified from information developed in public health advisories, public health assessments,

and health consultations. These actions include recommending the dissociation (separation) of individuals from exposures (for example, by providing an alternative water supply), conducting biologic indicators of exposure studies to assess exposure, and providing health education for health care providers and community members.

Public Health Advisory A statement by ATSDR containing a finding that a release of hazardous substances poses a significant risk to human health and recommending measures to be taken to reduce exposure and eliminate or substantially mitigate the significant risk to human health.

Public Health Assessment The evaluation of data and information on the release of hazardous substances into the environment in order to assess any current or future impact on public health, develop health advisories or other recommendations, and identify studies or actions needed to evaluate and mitigate or prevent human health effects; also, the document resulting from that evaluation.

Public Health Hazard Sites that pose a public health hazard as the result of long-term exposures to hazardous substances.

Public Health Statement The first chapter of an ATSDR toxicological profile. It is intended to be a health effects summary written in lay language for the target audience, that is, the general public, especially people living in the vicinity of a hazardous waste site or chemical release.

Receptor Population People who live or work in the path of one or more chemicals, and who could come into contact with them.

Reference Dose (RfD) An estimate, with safety factors built in, of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause harm.

Registry A system for collecting and maintaining, in a structured record, information on specific persons from a defined population. Preliminary analyses and reviews are performed.

Removal Action An immediate action taken over the short-term to address a release or threatened release of hazardous substances.

Risk In risk assessment, the probability that something will cause injury, combined with the potential severity of that injury.

Route of Exposure The way in which a person may contact a chemical substance. There are three exposure routes: inhalation (breathing), ingestion (eating or drinking) and dermal contact (absorbing something through the skin).

Significant Health Risk Circumstances where people are being or could be exposed to hazardous substances at levels that pose an urgent public health hazard or a public health hazard; public health advisories are generally issued when urgent public health hazards have been identified.

Source of Contamination The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway.**

Special or Sensitive Populations People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics A branch of the math process of collecting, looking at, and summarizing data or information.

Superfund Another name for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), which created ATSDR.

SARA Superfund Amendments and Reauthorization Act. The 1986 legislation that broadened ATSDR's responsibilities in the areas of public health assessments, establishment and maintenance of toxicological databases, information dissemination, and medical education.

Toxic Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology The study of the harmful effects of chemicals on humans or animals.

Tumor Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty factor see **Safety factor.**

Urgent Public Health Hazard This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

Volatile Organic Compounds (VOCs) Substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen; these substances easily become vapors or gases. A significant number of the *VOCs* are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry cleaning fluids).

Vuggy A small cavity in a rock or vein, often with a mineral lining of different composition from that of the surrounding rock.

ATSDR-Specific Terms

Toxicological Profile A document about a specific substance in which ATSDR scientists interpret all known information on the substance and specify the levels at which people may be harmed if exposed. The *toxicological profile* also identifies significant gaps in knowledge on the substance, and serves to initiate further research, where needed.